

Wireless Network Design Considerations

1.0 Overview

1.1 Introduction

In a wireless network design, there are several factors to consider. This document is broken into sections to provide a series of questions for fact finding to better address wireless design concerns.

The questions listed were primarily referenced in Gartner Research paper G00171433 *Toolkit: Technology Section of a WLAN RFP* as well as Gartner Research paper G001261303 *Network Access for Guests or Contractors Requires More than an Open Network Coffee-Shop Strategy* and supplemented by conversations with Gartner Fellow Tim Zimmermann and WNYRIC staff.

1.2 Document intention

- The intent of this document is to provide an overall questionnaire;
 - To aide a proper wireless network design
 - To elicit district input to design decisions,
 - To document the decisions the district chose,
 - And to provide a default answer in absence of district input.
- *It is important to understand this document is intended to solicit input and design criteria to determine a proper solution based on the district requirements. It is not intended to conflict with past recommendations as those were developed with older technology and different design decisions.*
- This is intended to be a “living” document, evolving with changing district requirements and technology advancements.

2.0 The End-User Experience

2.1 User counts and type determination

- Who are the wireless users and what uses/applications will they need from the wireless network?
 - I.e. Students, Teachers, Office Staff, Guests, Contractors, Vendors, Facility, Support Staff, etc.
 - I.e. Internet, videoconference, VoWLAN, assessment testing, file transfers, etc.
- Are there wireless units such as printers, control systems, cameras, MiDi, Widi, TVs that will use the wireless network?
- What are the "lite client" devices (i.e.; Chromebooks, iPads, etc) and are Cloud Applications to be utilized..
- What is the best estimate for growth in the next few years for both users and capacity?
- **Default design without specific input**
 - ***Plan that all students and staff will use the wireless network.***
 - ***Plan that visitors and guests will use the wireless network.***
 - ***Plan for 3 devices per 1 user ratio.***

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2.2 Per-User Capacity Planning

- What are the current and potential applications and usage scenarios?
- What WLAN requirements are associated with each application?
- What is the peak, average, concurrent capacity or throughput is needed by each type of user, in each application scenario?
- 802.11 AC Wave 1 is now available, be aware that 802.11 AC wave 2 is scheduled for ratification in Fall 2015. Be aware that upgrade on Wave 1 equipment to Wave 2 is not feasible.
- Configure QOS for Wireless Voip.
- **Default design without specific input**
 - *Plan on 5 Mbps per user concurrently.*
 - *This means using 802.11n and 802.11AC wave 1 and wave 2 (pending) rather than 802.11g. This allows supports 5 devices per AP at 5 Mbps.*
 - *Many WLANs have been designed for "connection" and not for "capability." Designed for connection means that clients are able to connect to the wireless infrastructure, and, although the access point can transmit up to 54 Mbps in an 802.11g environment, the user may experience only 1 Mbps of raw throughput.*

2.3 Coverage Areas and Density

- Are there building diagrams? Are they dimensioned properly?
 - Are there CAD/building material drawings that can be imported into a design-planning tool?
 - Lacking the CAD drawings, are their other building diagrams available in JPEG format for hand drawings?
 - Are the wiring closet locations and cable locations known, documented, and marked appropriately on diagram?
- Where, when and for what purpose will the wireless network be used?
- How many users/devices will be using the wireless network in what locations?
- Are there privacy and security Board Policies in place in the district today, if so, what are these?
- Is the district willing to invest in a predesign wireless site survey to determine current coverage and availability?
- Will the district invest in a wireless site survey on an annual basis?
- **Default design without specific input**
 - *Plan 1 AP and 2 Cat6a drops per classroom and an office area with potential of 30 users per AP.*
 - *You should pPlan to support 100 or more client devices in large areas such as auditorium, cafeteria, gymnasium, and athletic*

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fields. Auditoriums should use radio strength and directional antennas.

- *A post installation wireless site survey will be performed to audit and remediate installation and provided as a "living document" to the school district.*
- *Schedule annual site survey at time of project completion*
- *DO NOT use mobile AP's such as AP on a mobile cart. It causes interference and changes the wireless environment.*
- *Purchase 5% additional AP's units for design supplement and testing.*

2.4 Transaction Density

- **Default design**
 - *Transaction density will be determined by the client density and user/application capacity needs.*

2.5 Definition of Types of Clients

- What types of client devices will be using the wireless network? What type of radios, antennae and transmit power are available in the clients?
 - I.e. laptops, desktops, tablets, smartphones, VoWLAN handsets, wireless network printers and scanners, security cameras, Wi-Fi active RFID tags, MiDi, Widi, TVs.
- What devices will be configured for 802.11b/g, 802.11a, 802.11n, and/or 802.11ac in what frequency ranges of 2.4 Ghz and 5.0 Ghz?
- **Default design without specific input**
 - *Plan for iPads, which have a single radio with the weakest transmit power of most devices.*
 - *Utilize the 5.0 Ghz spectrum when possible.*
 - *Recommend 802.11 ac and eliminate 802.11b/g/a systems.*
 - *Minimize all 802.11g systems, and 2.4 Ghz 802.11n if they can't be eliminated.*
 - *Ensure client drivers and software are regularly scheduled and updated to latest approved releases.*

Recommend wiring potential wireless units such as printers, interactive learning devices, control systems, cameras, MiDi, Widi, TVs

3.0 Environmental and Operating Conditions

3.1 Site Survey and Monitoring

- What is the environmental noise floor for the areas where the WLAN will be installed for 2.4GHz and 5GHz?
- What is the signal-to-noise ratio policy for the district?
- Do any areas require special antennas?
- Has a spectrum analysis been done as part of a wireless site survey?
- What will be the ongoing plan for non-WiFi interference monitoring?

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- **Default design without specific input**
 - *Use a signal-to-noise ratio of 25 dB*
 - *Without a specific survey, design 1 AP per room*
 - *Optionally, use Ekahau planning tool for design*
 - *Provide a means to perform spectrum analysis and interference monitoring both pre and post installation.*
 - *Use AP's with built in function or use on-site probes*

3.2 Linking the WLAN Components to the Wired Infrastructure

- Is there proper wiring to connect the proposed AP locations?
 - Will the wire support gigabit Ethernet?
 - Cat 6a cabling is recommended due to distance limitations with 10 Gb throughput
- Plan on needed POE+ 30 Watts per port to power AP's with AC Radio's
- Can the district provide clean and consistent power to the AP's and PoE switches?
- Is there a need for dual wires to each AP to ensure future growth?
- Is there a plan or process to put in new cabling if needed (capital project)?
- Are there other devices that require PoE as well, such as security cameras?
- Can the design support the new standard for approx 2.5 GB over existing cabling?
- Is there a proper count and wiring design to show how many powered devices will be in each wiring closet?
- Is there a need for wired areas that are high density and demand such as AutoCAD labs?
- **Default design without specific input**
 - *Add enough switches to the project to provide minimally 24 port PoE+ to each wiring closet.*
 - *Recommend dedicated 2 Cat6a wiring drops to each AP.*
 - *Do not repurpose a desktop drop unless it is relocated.*
 - *Wiring drop must have female end to allow for 15' service loop (patch cable).*
 - *Without cabling plan the only option would be to identify if there is an existing drop to the locations that can be used.*
 - *Allow for multiple ports in core of network with a minimum 4 port Link Aggregation Group (LAG), recommend 2 x 10Gb between the wireless controller and core network switches.*
 - *Assume the district has good and consistent power for AP's and PoE switches with UPS in every closet and generator backup.*

3.3 High availability

- What level of reliability should the infrastructure be designed to accommodate?
- Is overlapping coverage of adjacent access points required?
- Wireless controller redundancy with redundant power supplies is preferred

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- If there is a problem with the Ethernet cabling, is a wireless mesh, which allows the access points to communicate to each other required?
- Are multi-homed access points required (i.e., be able to have primary and second wired connections to different upstream switches)?
- **Default design without specific input**
 - **Provide high availability controllers and redundant power supplies**
 - **Provide multi-homed AP's as permitted by cabling**

3.4 Maintenance and Repair

- What does the district desire for maintenance options?
 - Does the district want a same day or next business day replacement contract, or will the district carry spare components?
 - Does the district have a maintenance plan to keep all wireless network equipment and management components up to date for software?
- **Default design without specific input**
 - **Provide same day replacement on controllers**
 - **Provide licensing of software updates on all components**
 - **Do not purchase maintenance on AP's.**
 - **Communicate to the district whether or not the AP's have lifetime replacements.**

3.5 Network Management

- Does the district want to manage the wireless network or does the district wish to contract management?
- Who is responsible in the district for maintaining MAC addresses of district owned devices?
- Is there a need for the Guest Network be available after hours?
- Is there a need for multivendor support?
 - Please identify all supported vendors.
- Does the wireless network management application need to integrate with the wired enterprise management strategy?
- What is the district policy for rogue AP enforcement?
- Does the district have a policy for working with AP's from the neighborhood and how it interferes with the wireless network?
- How does the district want to identify and replace failed components?
 - Who should get alerts and provide diagnostics?
- Does the district want to enable auto-tuning of the AP's or should that function be provided manually?
- Does the district want historical trend and network usage reporting?
- Does the district desire a post site survey to audit/remediate the design?

Default design without specific input

- **The RIC will manage the system and perform all repairs.**

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- *Build a network management system for district use, import diagrams as available, generate heat maps as capable, and input building materials on the maps as possible.*
- *Rogue AP's will be identified and manually removed if on district property.*
- *Alerts will go to RIC and appropriate district personnel.*
- *The system will be set to 'auto tune.'*
- *A post site survey will be performed and provided to the district.*
- *Schedule annual site surveys as part of the project.*

3.6 Migration Strategy for Existing Mixed Networks

- Are there legacy access points that will remain in service?
 - Is there a desire to keep legacy system in different building?
- Will the new solution manage the legacy AP's?
 - Is it acceptable to have multiple management systems if needed?
- **Default design without specific input**
 - *Replace all the existing AP's and controllers to allow for a single system; at a minimum segregate systems by building.*

4.0 Network Services

4.1 Security and Authentication

- Because of rapid changes in Wireless Security and Authentication these questions and recommendations will continue to change in near future.
- Will the client devices support WPA2-AES?
 - Are there clients that do not support WPA2-AES?
- Will the Extensible Authentication Protocol (802.1x) be used?
 - Is the server infrastructure available to support EAP?
 - Does the recommended solution have an integrated RADIUS option, or is an external server required?
 - Are there any limitations associated with the supplicants that can be used?
- Does the district have a policy in place to address BYOD and Guest access?
 - Is there a VLAN structure that will support segregation by firewall and routing segmentation for BYOD, Guest, and Internal devices?
- Is a captive portal guest access solution needed?
 - Does the district require device registration for guest or BYOD access?
- Is posture checking and device interrogation/remediation desired (OS and patch levels)?
- Radius with districts adding MAC addresses or WAN Senior Network Engineers adding MAC addresses. Can these be uploaded from another network system (DHCP)?
- Workstation level login for non-windows systems
- Work in conjunction with Content Filtering, ensure filtering is effective so students don't use this network, but guests can
- Is there a desire for rogue device/AP detection and remediation?

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- Will the district get rid of pre-shared keys?
- **Default design without specific input**
 - **Use WPA2-AES**
 - **Use 802.1x**
 - **Understand that this technology is rapidly changing so a review based on new technology is needed frequently during the planning process.**
 - **Use Authentication system (i.e. Identity Engines, ISE, Bradford, ClearPass, Microsoft NPS)**
 - **Identify the device ownership by MAC Address using an MDM Solution**
 - **Identify the user by district directory**
 - **Based on the following query do the following**
 - **Route Guest Vlan to FW with minimum Student or Guest Filtering**

Machine Type	Auth	Encryption	Key	FW from District	WS Login	Filtering
District Owned - Windows	802.1x (AD Mach. Auth)	WPA2 Enterprise	802.1x Generated	No	AD	Force login of non-authorized systems
District Owned – Non Windows	802.1x Or WPA2 (Mac or Single AD User) (1)	WPA 2 Enterprise or Personal	Well Known Key (2)	No	(3)?	Force login of non-authorized systems
BYOD	802.1x Or WP2 (AD Mach. Auth)	WPA 2 Enterprise or Personal	Well Known Key (2)	Yes	N/A	Force login of non-authorized systems
Guest	Splash Page with Auth. System - AUP	Web Authentication	802.1x Generated	Yes	N/A	Default
VoIP	MAC on Wireless Controller	WPA 2 Personal	Well Known Key (2)	No	N/A	None?

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4.2 Advanced Network Protocols

- Is support Wi-Fi Multimedia for quality of service (QoS) needed?
- Is support of VoIP wireless handsets needed?
- Is support for multicast frames needed?
- **Default design without specific input**
 - **Enable WiFi Multimedia (WMM) for Voice QoS**
 - **Enable Call Admission Control (CAC)**
 - **Ensure ability to control MDNS (Bonjour) traffic**

4.3 Location-Based Services

- Are location-based services required?
- What is the documented proximity to the asset that is needed?
- **Default design without specific input**
 - **Include location services, with accuracy within 5 meters**
 - **Location is a factor of AP density and diagram accuracy**

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References

Zimmerman, T. King, M. (2009, November 11). *Toolkit: Technology Section of a WLAN RFP*. Gartner G00171433

Dziuba, M. Holbrook, J. (2012, September 19). *Discussion input from Sr. LAN/WAN meeting*. Recorded at Erie 1 BOCES/WNYRIC on September 19, 2012 and October 3, 2012.

Zimmerman, T. *Network Access for Guests or Contractors Requires More than an Open Network Coffee-Shop Strategy*. Gartner G001261303

WNYRIC WAN Senior Network Engineer (2014, April 23) *Discussion input from Sr. LAN/WAN meeting*. Recorded at Erie 1 BOCES/WNYRIC on April 23, 2014